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is proved in the preceding chapter. See also *The Transactions of the American Mathematical Society,* Vol. 3, pp. 372-376, July, 1902.) This cubic will have at most four points in common with the point row of the second order besides the double point S. These points are easily seen to be the points involved in the problem. We see then, that at most four rays of the pencil pass through the points of the point row that correspond to them.

Equipped with this last theorem we are able to discuss the theorem indicated by Professor Reye: *The locus of points of intersection of the tangents of one conic which are conjugate with respect to another is a third conic.*

Given two conics, α and β. From a point, P, which moves along an arbitrary straight line in the plane draw tangents, PA and PA' to the conic α. We wish to find in how many positions of P on the line the two tangents PA and PA' will be conjugate with respect to β. The two systems of tangents PA and PA' are in involution, so that four harmonic tangents, PA, correspond to four harmonic tangents PA'. The pole of PA, the locus of which is the polar reciprocal of α with respect to β, traces out a point row of the second order projective to PA and thus to PA'. At most four of these poles of PA will therefore lie on PA'. The locus is thus a curve of the fourth degree, being cut by an arbitrary line in at most four points. From the theory of poles and polars, however, if PA' pass through the polar of PA, then will PA' pass through the polar of PA, so that the four points in which an arbitrary line meets the locus coincide in pairs; the quartic is thus a pair of coincident conics.

It is clear that the tangents PB and PB', for a point P on this locus, are harmonic conjugates with respect to PA and PA'. The locus of points from which four harmonic tangents may be drawn to two conics is thus a conic. It is in fact the covariant conic of the two conics. For the analytic side of the discussion, see Salmon's *Conic Sections,* pp. 306 and 344. If the anharmonic ratio of the four tangents be different from -1, the quartic found above does not degenerate necessarily, as appears also from the algebraic discussion. The writer does not know of a discussion by synthetic methods of this remarkable conic, which as the above discussion indicates, passes through the eight points of contact of the four common tangents of the two conics.

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JOINT MEETING OF MATHEMATICIANS AND ENGINEERS.

By DR. H. E. SLAUGHT, The University of Chicago.

A series of joint meetings of mathematicians and engineers, conducted at The University of Chicago, December 30, 31, 1907, under the auspices of the Chicago Section of the American Mathematical Society, seemed to inaugurate a movement of more than passing importance to both parties concerned. It would seem that these two classes of men have been pursuing paths too widely separated, each class failing to appreciate how large a proportion of their interests may really be counted in the field of the other. Recognition of this community of interests coupled with the great divergence of practice led to a number of significant results: (1) Astonishment that this state of affairs has gone so long with so little serious attention; (2) Gratification over the gathering of such a large and representative body of professors of mathematics, professors of engineering, and practicing engineers for the purpose of thoughtfully considering together the questions of commanding mutual interest; and (3) The determination to take active and far-reaching steps toward harmonizing and strengthening those interests.

The program presented first the historical and statistical phases of the subject both in this country and abroad, and secondly, the pedagogical and practical phases as they appear both to the practicing engineer and to the professor in the engineering school. The discussion was focused about the topic: What is needed in the teaching of mathematics to students of engineering? (a) What range of subjects? (b) To what extent in the various subjects? (c) By what methods of presentation? (d) What should be the chief aim?

The speakers were as follows: Professor E. J. Townsend, department of mathematics, University of Illinois; Professor Alexander Ziwet, department of mathematics, University of Michigan; President R. S. Woodward, Carnegie Institution of Washington; Mr. C. F. Scott, consulting engineer, Westinghouse Electric Company of Pittsburg; Mr. Ralph Modjeski, consulting civil engineer, Chicago, Illinois; Charles S. Slichter, professor of applied mathematics and consulting engineer, University of Wisconsin; Gardner S. Williams, professor of civil, hydraulic, and sanitary engineering, University of Michigan; Frederick S. Woods, professor of mathematics, Massachusetts Institute of Technology, Boston, Massachusetts; George F. Swain, professor of civil engineering, Massachusetts Institute of Technology, Boston, Massachusetts; Arthur N. Talbot, professor of municipal and sanitary engineering in charge of theoretical and applied mechanics, University of Illinois; Fred W. McNair, president, Michigan College of Mines, Houghton, Michigan, and Mr. J. A. L. Waddell, consulting bridge engineer, Kansas City, Missouri.

The general discussion was supported by Mr. C. F. Scott, Pittsburg, Pennsylvania; Dean C. M. Woodward, Washington University; Professor B. F. Groat, School of Mines, University of Minnesota; Professor S. M. Barton, University of the South; President C. S. Howe, Case School of Applied Science; Professor C. A. Waldo, Purdue University; Professor C. B. Williams, Kalamazoo College; Mr. J. B. Webb, consulting engineer, Hoboken, New Jersey; Dean H. T. Eddy, College of Engineering, University of Minnesota; Professor D. F. Campbell, Armour Institute of Technology; Professor A. E. Haynes, College of Engineering, University of Minnesota; Professor E. W. Davis, University of Nebraska; Professor A. S. Hathaway, Rose Polytechnic Institute; and Professor E. V. Huntington, Harvard University.

Abstracts of the addresses will appear in *The Bulletin of the American Mathematical Society,* and the papers will be printed in full in *Science.*

As an outcome of the discussions, a committee of three was appointed with power to increase the number to fifteen, representing all interests and all sections of the country, who shall make a detailed study of the teaching of mathematics to engineering students in this country, and shall formulate a report to be presented to a joint meeting of mathematicians and engineers to be held in the Summer of 1909 in connection with the annual gathering of the Society for the Promotion of Engineering Education. Those selected for the committee of three were: Professor Gardner S. Williams, University of Michigan, representing the engineering side; Professor E. V. Huntington, Harvard University, representing the mathematical side, and Professor E. J. Townsend, who has already made an extensive study of the data relating to the subject. Among the practical questions already suggested by Professor Townsend for the consideration of all interested are the following:

I. Entrance Requirements.

1. Is a greater uniformity of entrance requirements desirable?
2. Most colleges in the Middle West admit on certificates from accredited schools. In addition to this should engineering students be required to pass an entrance examination in algebra, with the understanding that if they fail to make satisfactory grade, more than the usual amount of work must be done to secure credit in college algebra?
3. Should a knowledge of logarithms and the plotting of simple algebraic curves be added to the entrance requirements?
4. Should the standard of admission be raised so as to include trigonometry and college algebra?
5. Should the requirements be made to cover less ground and intensified?
6. Should more attention be paid to analytic and formal work, particularly in arithmetic and algebra?
7. Should a year of work in mathematics and science of college grade be required for entrance, or should the course be extended to five years?

II. Requirements for Graduation.

1. What should be the relative length of time spent on algebra, trigonometry, analytical geometry, and calculus?
2. Which should precede, algebra or trigonometry?
3. What topics should be particularly emphasized in college algebra? In calculus?
4. How far ought the instruction of the first two years' work in math-

ematics to be made "practical"; how far should we insist upon rigorous demonstrations of principles taught?

5. Should students in one line of engineering, say civil engineering, be given problems of a different nature than those given to students in other lines, say mechanical or electrical engineering?

6. Should differential equations and least squares be required subjects in any engineering course? If so, how extensive should these courses be?

7. Should we have a separate course on "Applications," having for its purpose the cultivation of ability for rapid computation, and the use for engineering work of such instruments as the slide rule, planimeter, integraph, computing machines, etc.?

8. What opportunity for the study of mathematics should be given the engineer beyond the usual course in calculus? What courses might be made elective in the junior or senior years?

9. Should a first course in mechanics be given to engineering students in the freshman year and before the student has had calculus?

III. ADMINISTRATIVE QUESTIONS.

1. What qualifications should we insist upon for the instructor of engineering students in mathematics?

2. How much elementary mechanics should be taught in connection with the calculus? Should this elementary mechanics be taught by the mathematical department?

3. Should the work in descriptive geometry be made more mathematical in treatment? Should it be taught by the mathematical department?

4. What can be done in general to bring about a closer ralation between the teachers of mathematics and the teachers of engineering?

Pending the report of the Committee of Fifteen, these and other questions relating to the subject may well command the attention of those who wish to promote the scientific and industrial interests of the country as they are related to the training of men who are to be leaders in their development.

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REMARK ON THE TRISECTION PROBLEM.

By E. B. ESCOTT, University of Michigan.

In the article "The Trisection Problem,"* in the May (1907) number of THE AMERICAN MATHEMATICAL MONTHLY; the so-called "Ceroid" is

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*The merit of the article referred to lies in the fact that its author inadvertently rediscovered the famous curve and applied it in a new manner. The same author makes use of the hyperbolic curve for trisecting an angle, which of itself is well known, but which is presented in a new form worthy of attention. THE EDITORS.